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(54) Self phased antenna element with dielectric

(57) A self phased antenna element with two pairs of arms 110, 120, 130, 140 in a crossed relationship transceives a signal at a resonant frequency. A dielectric 150, 160 is disposed adjacent or touching an arm 130, 140 to obtain a self phased relationship in the arms 110, 120, 130, 140 at the resonant frequency. The arms can form crossed loops (fig 8) or twisted crossed loops such as a quadrifilar helix antenna element. A dielectric collar 150, 160 on arms of the same loop causes arm currents to be equally spaced from one another. The antenna size is reduced and a cross section of the antenna element appears circular without degradation of a gain pattern when the dielectric is used on the certain arm. Dielectric members (520, 530, 540, 550, fig 5, 6) may be molded into the sides (513, 515, fig 5, 6) of a radome.

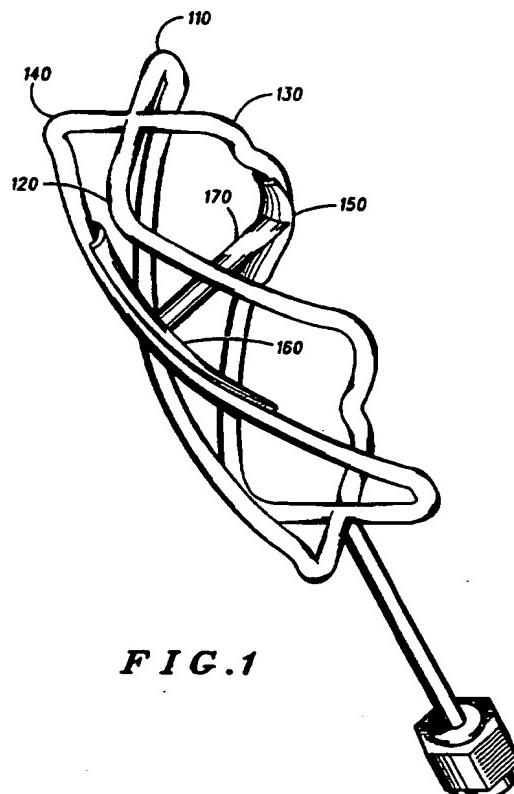


FIG.1

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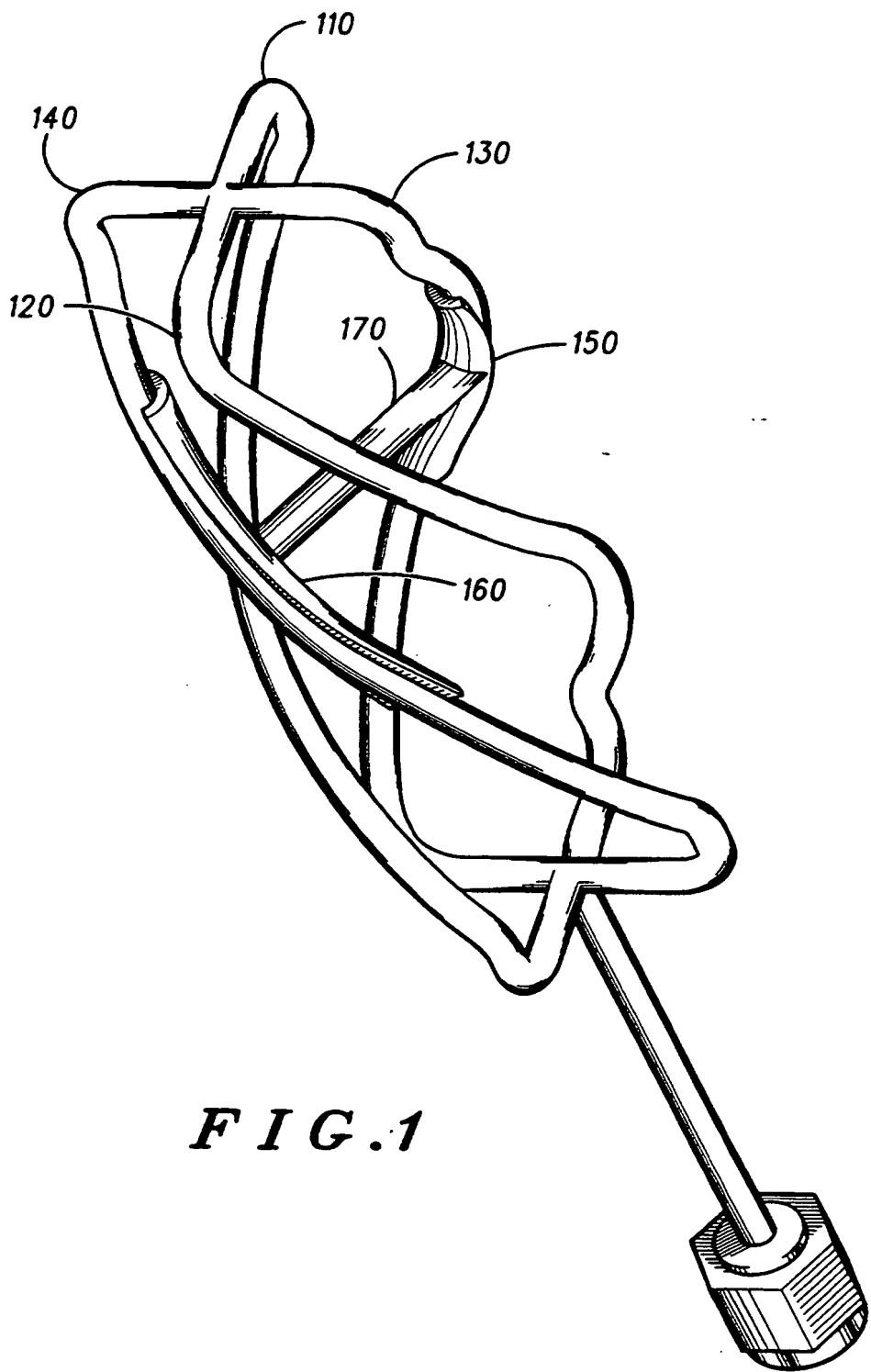
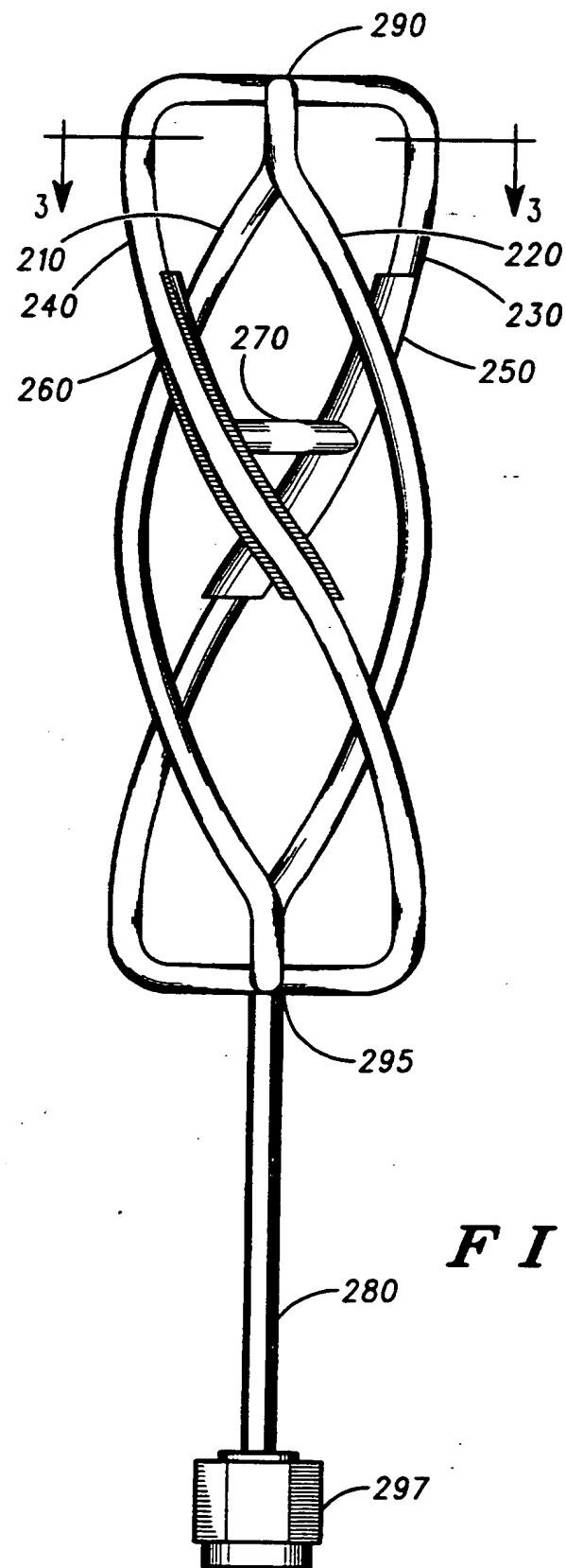


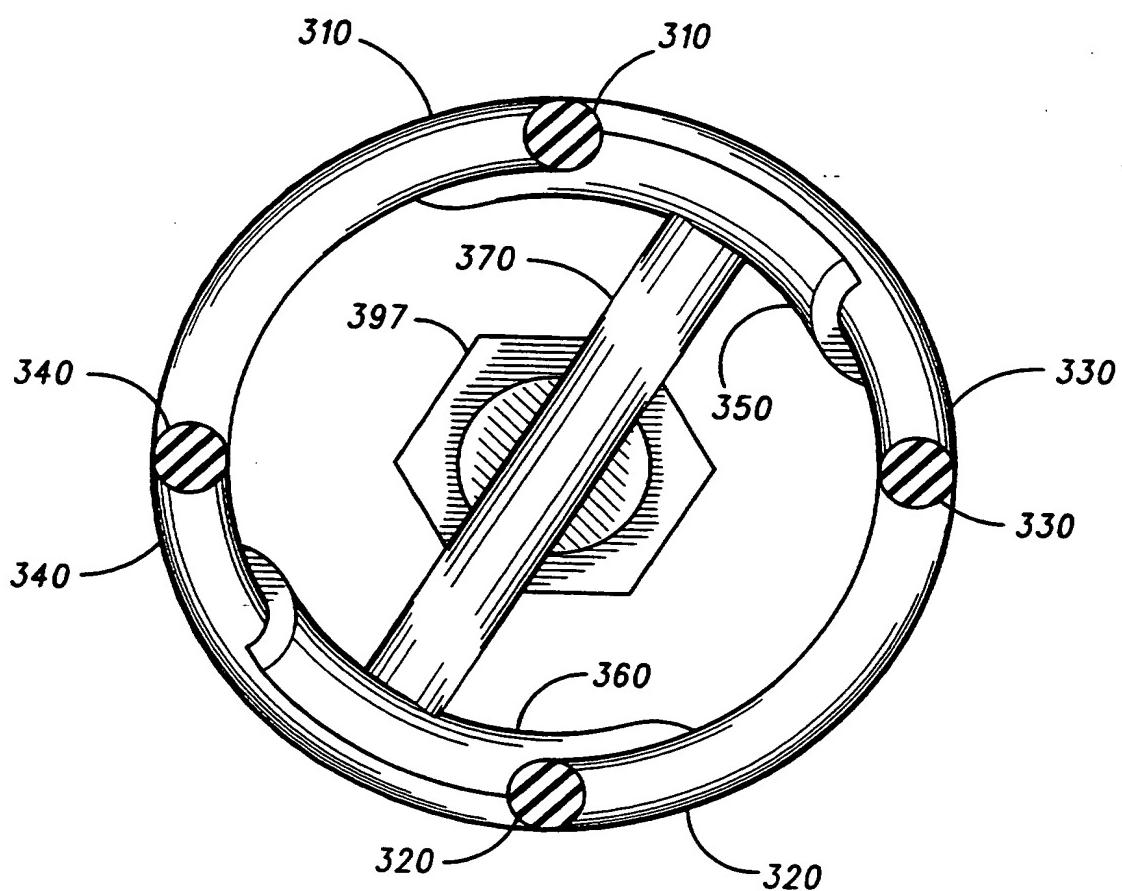
FIG. 1

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F I G . 2

3 / 6



F I G . 3

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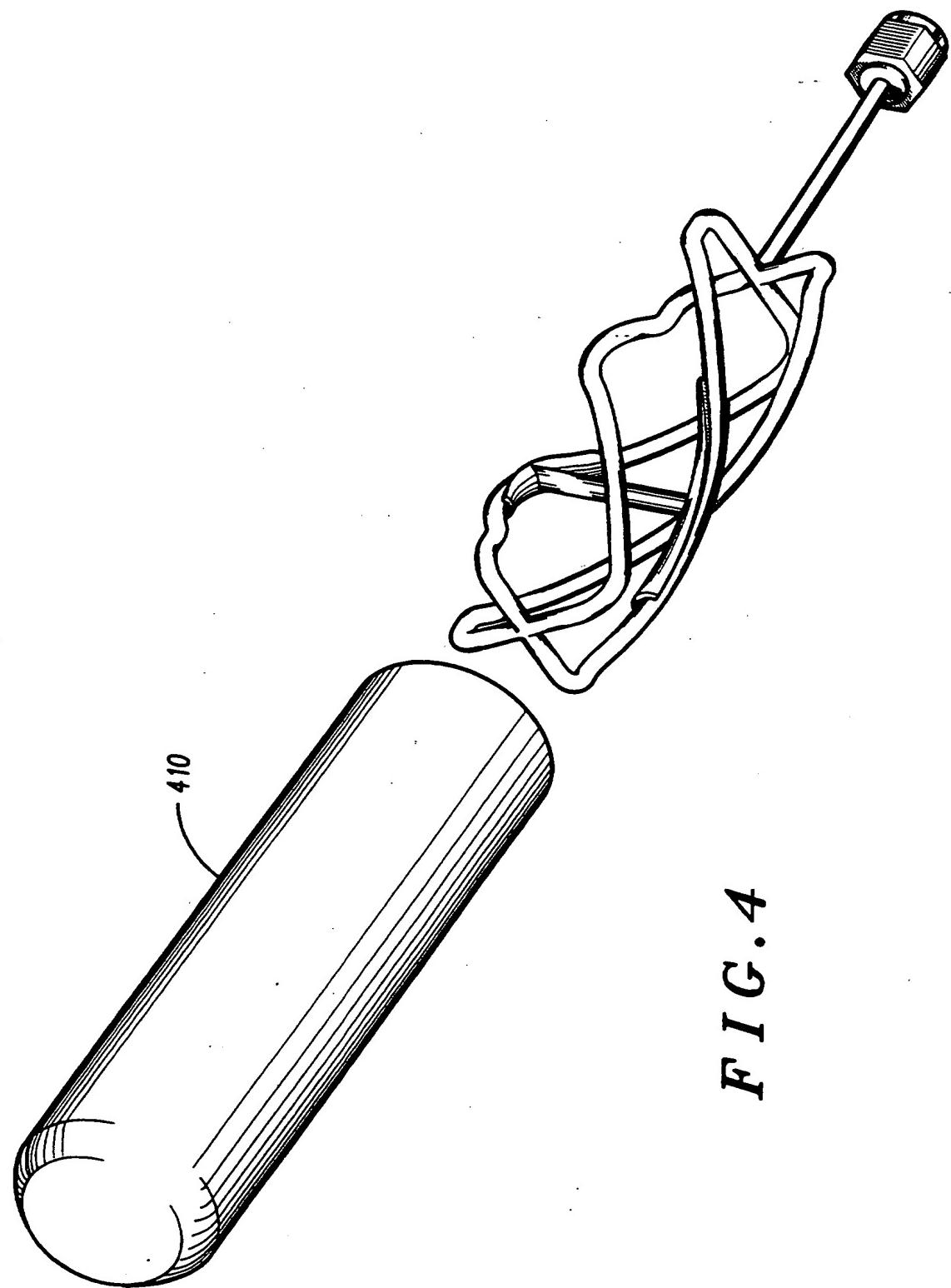


FIG. 4

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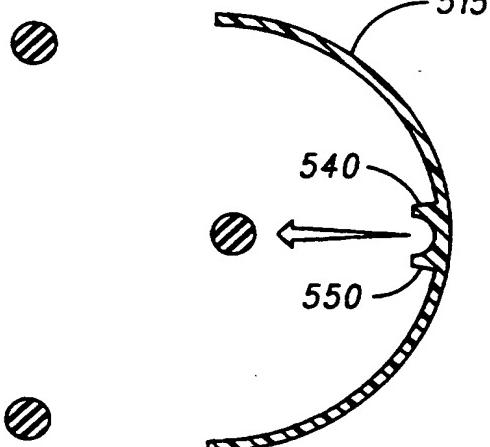
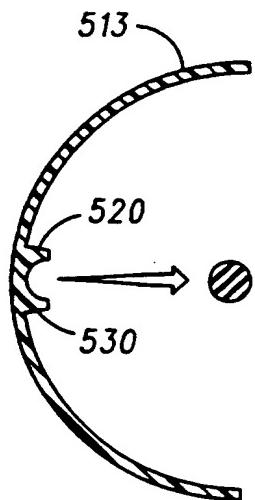


FIG. 5

FIG. 6

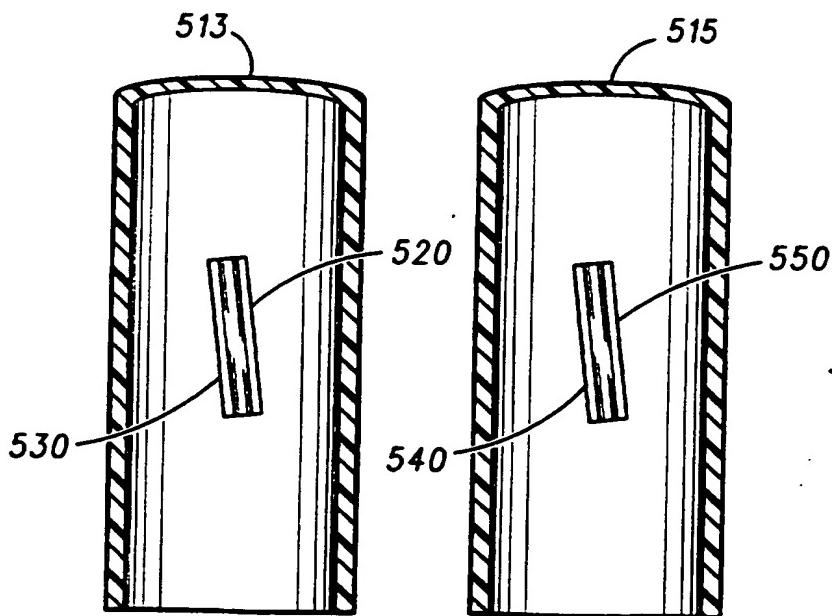
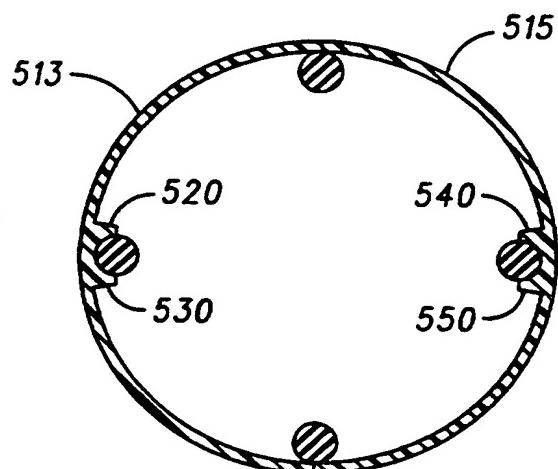
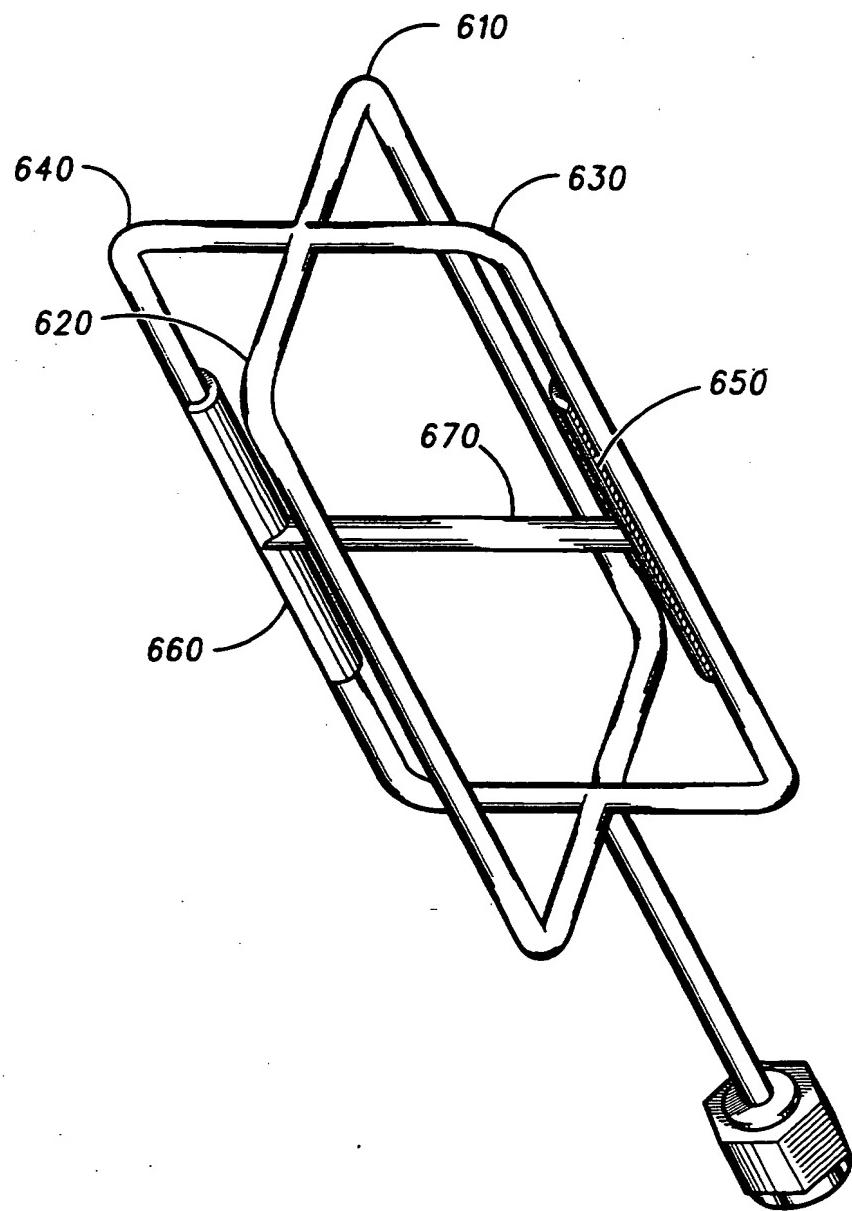


FIG. 7

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F I G . 8

SELF PHASED ANTENNA ELEMENT WITH DIELECTRIC AND ASSOCIATED METHOD

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Background of the Invention

1. Technical Field of the Invention

The invention is directed towards antenna elements and, more particularly, is directed towards antenna elements that are self phased using a dielectric.

2. Description of the Related Art

Many antennas have antenna elements made of pairs of arms. In crossed loop or quadrifilar helix antenna elements, a pair of arms forms a loop and two loops are crossed at 90 degrees. Known quadrifilar helix antennas typically have two crossed loops of different lengths. The two loops are twisted to form quarter-wave volutes, half-wave volutes, three-quarter-wave volutes or full-wave volutes. Other configurations of arms that produce circularly-polarized radiation patterns are also within the art.

The two loops of the quadrifilar helix antenna radiate with circular polarization when the antenna is self phased. In the art, quadrifilar helix antennas or crossed loop antennas are self phased when one of the loops is larger relative to the desired resonant frequency. The larger loop appears capacitive and has a positive imaginary component, and the smaller loop is inductive and has a negative imaginary component. Ideally, when the antenna element is self-phased, the capacitive and inductive components (imaginary components) cancel, and the antenna appears purely resistive. This self-phased antenna thus obtain quadrature or 90 degree phase difference between currents in the loops, thus producing a self phased and circularly polarized current relationship therein.

A problem with the quadrifilar helix antenna elements and the crossed loop antenna elements is that the orthogonal loops are designed such that the antenna elements are wider in one direction than in the other direction. The antenna elements are wider in one direction than in
5 the other direction because one loop is larger than the other. Preferably, the antenna element is shaped as narrow as possible and formed as thinly as possible. Usually, the larger loop causes the antenna to have a width approximately fifteen percent larger in one direction than the other. Such a larger loop causes the cross-section of a crossed loop antenna or a
10 quadrifilar helix antenna to have an oval cross-section, rather than a smaller and more aesthetically pleasing circular cross-section. The present invention allows the antenna size to be reduced by providing a smaller cross-section of an ideally circular shape.

The size of antennas have been reduced in the art by narrowing or shortening the overall dimensions of an antenna. One might try reducing the respective sizes of the two loops of a quadrifilar helix antenna such that the loops have the same size. Altering the respective dimensions of arms within an antenna, however, distorts the gain pattern of the antenna. Creating a smaller looking antenna by reducing the antenna's dimensions, also reduces the antenna's gain by a few or more decibels. In
15 a device such as a low-power, portable satellite transceiver for communicating with non-geosynchronous satellites, a uniform and low-loss antenna gain pattern is important. Small size, particularly in diameter, is also desired to improve portability and user desirability. The present invention reduces antenna size while maintaining a desired gain
20 pattern not heretofore possible without the oval cross-section of the known crossed loop or quadrifilar helix antennas.
25

Antennas having multiple arms are also difficult to manufacture with accuracy. Special fixtures are needed during the manufacturing process when soldering arms together to form the antenna element. The arms must be perfectly dimensioned to provide an ideal gain pattern with minimum loss. Further, techniques for improving accuracy of multiple-armed antennas are desired. Techniques for reducing or eliminating special fixtures during assembly of multiple-armed antennas are
30 additionally needed.
35

Brief Description of the Drawings

FIG. 1 illustrates a perspective view of a quadrifilar helix antenna element with dielectric according to the present invention;

5 FIG. 2 illustrates a side view of the quadrifilar helix antenna element with dielectric according to the present invention;

FIG. 3 illustrates a cross-section of the quadrifilar helix antenna element with dielectric of FIG. 2 according to the present invention;

10 FIG. 4 illustrates a radome for housing the antenna element with dielectric according to the present invention;

FIGS. 5-7 illustrate an alternative embodiment for housing the antenna element according to the present invention; and

15 FIG. 8 illustrates a perspective view of a crossed loop antenna element with dielectric according to the present invention.

Detailed Description of the Preferred Embodiments

FIG. 1 illustrates a perspective view of a quadrifilar helix antenna element with dielectric according to the present invention. The quadrifilar helix antenna element has four arms 110, 120, 130 and 140. A first pair of the arms 110 and 120 forms a first loop and a second pair of the arms 130 and 140 forms a second loop. A dielectric 150 and 160 is provided adjacent to the arms of one of the two loops of the quadrifilar helix antenna element. The dielectric 150 or 160 is preferably formed in the shape of a collar wrapped around an arm of the loop. The collar can completely encapsulate an arm and form a sleeve. The collar preferably partially-encapsulates the arm. When the dielectric collar partially encapsulates the arm, the dielectric material preferably faces an inside of the loop as illustrated. When the dielectric material faces an inside of the loop, exterior dimensions are further reduced and an even smaller cross-sectional size of the antenna element is provided.

Dimensions of the dielectric such as length, thickness, width and amount of encapsulation affect the phasing of currents in the associated loop or arm. Further, the type of dielectric material is preferably a plastic material often used in injection molded processes. The type of dielectric material will affect the phasing of currents in the associated loop or arm. The number of dielectric members will also affect the phasing of currents

in the associated loop or arm. Should the dielectric member be formed by a process other than injection molding, other materials are known to be capable of producing a suitable dielectric property.

During manufacturing or assembly of an antenna element, the
5 dielectric collar of FIG. 1 can merely be slid up and down along an arm to trim or slightly adjust the phasing of currents in the associated arm. Although less preferred, the length of a chosen dielectric material could also be shortened during manufacture to adjust the phasing of currents. Besides reducing antenna size and cross-sectional diameter, the present
10 invention provides a simple mechanism for tuning the antenna.

Although the antenna element can be self phased and its size reduced using only one dielectric member adjacent to one arm, two dielectric collars 150 and 160 are preferably disposed on two respective arms. By using two dielectric collars on two respective arms, a truss
15 member 170 can support the arms 130 and 140 between the collars 150 and 160. The support by the truss member 170 absorbs compression forces between the arms. Multiple truss members 170 or a continuous piece of dielectric can also be used for support between arms. Through use of a truss member 170 for support between arms, the truss member supports
20 the arms during soldering. Special fixtures used to maintain positioning of the arms during assembly are thus avoided.

A quadrifilar helix antenna element or a crossed loop antenna element according to the present invention has two crossed loops of the same size. When one of these same size loops has the dielectric material,
25 it becomes more inductive than the other loop. Thus when both loops are capacitive without the dielectric, adding the dielectric to one loop makes the one loop inductive. When an appropriate amount and type of dielectric is added along an appropriate position, the capacitive and
30 inductive components will cancel and the antenna element will appear purely resistive. Self phasing of the antenna element at the resonant frequency is thus achieved.

FIG. 2 illustrates a side view of the quadrifilar helix antenna element according to the present invention. A feed line 280 preferably is a semi-rigid coaxial transmission line having an inner conductor shielded by an outer copper tube. The feed line 280 will extend through one of the arms to a feed point of excitation at the top 290 of the quadrifilar helix element. At the feed point of excitation, the feed current will emerge from
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the coaxial cable or coaxial tubing and attach to an outer conductive surface of the arms. The feed point of excitation can alternatively be at the bottom 295. A coupling nut 297 is used to connect the feed line 280. Different forms of coupling and different lengths of the feed line 280 can be chosen without effecting radiating characteristics or a gain pattern of the antenna element. The overall construction of a quadrifilar helix or crossed loop antenna type element is known to those of skill in the art.

FIG. 3 illustrates a cross-section of the quadrifilar helix antenna element of FIG. 2. In FIG. 3, a downwardly looking view of the twisted arms 310, 320, 330, and 340 is shown. The partially-encapsulating dielectric collars 350 and 360 are supported by truss member 370. The coupling nut 397 is also illustrated.

FIG. 4 illustrates a radome 410 for housing the antenna element with dielectric according to the present invention. The radome 410 covers the exterior of the antenna element to physically house the delicate arm structures. To reduce cross-sectional diameter of the antenna element, the radome 410 has as small a diameter as practical. A type of material for the radome having hard and lightweight properties is preferred.

FIGS. 5-7 illustrate an alternative embodiment for housing the antenna element with dielectric according to the present invention. Instead of the arms alone supporting the dielectric members, the radome itself supports the dielectric members. Dielectric members 520, 530, 540 and 550 preferably are molded into respective radome sides 513 and 515. The radome has two sides 513 and 515 in one embodiment. Making the radome out of the two sides 513 and 515 facilitates assembly of the antenna element inside the radome between the dielectric members 520, 530, 540 and 550. To support the dielectric members from the radome, the dielectric members are preferably molded into the same material as the material of the radome. Other than the illustrated square-like shape, the dielectric members 520, 530, 540 and 550 can have different shapes to facilitate practical manufacture.

The dielectric collars 150 and 160 or dielectric members 520, 530, 540 and 550 preferably touch the arms to mechanically support the antenna element. Nevertheless, the dielectric collars 150 and 160 or dielectric members 520, 530, 540 and 550 can be adjacent to the antenna element without touching the arms. Placing the dielectric adjacent to the arms

without touching still allows self phasing of the antenna element but avoids the advantages of mechanical support.

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FIG. 8 illustrates a perspective view of a crossed loop antenna element with dielectric according to the present invention. A crossed loop antenna is structurally similar to a quadrifilar helix antenna except the two loops are not twisted. The crossed loop antenna element has four arms 610, 620, 630 and 640. A first pair of the arms 610 and 620 forms a first loop and a second pair of the arms 630 and 640 forms a second loop. A dielectric 650 and 660 is provided adjacent to the arms of one of the two loops.

Although the invention has been described and illustrated in the above description and drawings, it is understood that this description is by example only, and that numerous changes and modifications can be made by those skilled in the art without departing from the true spirit and scope of the invention. Although the above drawings depict only one antenna element, an array of antenna elements can be implemented in an antenna. The present invention is not limited to portable electronic radios such as radiotelephones and pagers but can be applied to other devices such as ground stations, fixed satellite telephone booths, and aircraft and marine stations. Further, the principles of the present invention are applicable to satellite as well as terrestrial based communications.

What is claimed is:

Claims

1. A self phased antenna element for transceiving a signal having a resonant frequency, said antenna element comprising:

5 at least two pairs of arms operatively connected at a feed point of excitation and disposed in a crossed relationship with one another; and
at least one dielectric member positioned adjacent to at least one of the arms, said dielectric member having characteristics chosen to cause said pairs of arms to obtain a self phased relationship with one another at 10 the resonant frequency.

2. An antenna element according to claim 1, wherein said self phased relationship occurs when phases of arm currents are equally spaced from one another.

15 3. An antenna element according to claim 1, wherein said dielectric member is of a material type and is of dimensions having characteristics to cause the self phased relationship at the resonant frequency.

20 4. An antenna element according to claim 1, wherein said dielectric member comprises a collar.

25 5. An antenna element according to claim 1, wherein said pair of arms forms a loop and wherein said dielectric member is formed by at least one partially-encapsulating collar facing an inside of the loop.

30 6. An antenna element according to claim 1,
wherein said pair of arms forms a loop; and
wherein said dielectric member comprises:

a first partially-encapsulating collar adjacent to a first of the pair of arms of the loop facing an inside of the loop; and

a second partially-encapsulating collar adjacent to a second of the pair of arms of the loop facing an inside of the loop; and

35 a truss member disposed between said first and said second collar to provide support.

7. An antenna element according to claim 1,
wherein said antenna element further comprises a radome disposed
about an outer perimeter of said at least two pairs of arms; and
wherein said dielectric member is provided on an inside surface of
said radome.
- 5
8. An antenna element according to claim 7, wherein said dielectric
member is integrally formed in the radome at an inside surface thereof.
- 10 9. A method of making a self phased antenna element having at least
two pairs of arms operatively connected at a feed point of excitation and
disposed in a crossed relationship with one another to transceive a signal
having a resonant frequency, said method comprising the steps of:
15 (a) disposing at least one dielectric member in a position adjacent to
at least one of the arms of the antenna element; and
(b) adjusting a position of the at least one dielectric member with
respect to an associated arm to cause the pairs of arms of the antenna
element to obtain a self phased relationship with one another at the
resonant frequency.
- 20 10. A method according to claim 9, wherein said step (b) of adjusting
comprises the substep of (b1) sliding the dielectric member along a length
of the at least one arm to adjust the position and cause the self phased
relationship.



The
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Application No: GB 9606202.1
Claims searched: 1-10

Examiner: Mr Conal Oram
Date of search: 14 June 1996

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): H1Q (QDA, QDC, QDE, QDH, QDJ)

Int Cl (Ed.6): H01Q (1/36, 7/00, 11/08, 11/14)

Other: Online: WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
X	GB 2292638 A (SYMMETRICOM) See page 10 lines 12-13, page 11 lines 13-20 and page 13 lines 8-16.	1-3
X	GB 2292257 A (BRANSON) See page 2 lines 22-35 and page 5 lines 9-17.	1-4, 9 and 10

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.